An Approach to the Biology Laboratory

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The author proposes a "free experimental" system that will provide students with an opportunity to develop basic laboratory skills and, at the same time, gain continuity in their laboratory work.

The smell of formaldehyde is gradually disappearing from the high school biology laboratory, but I wonder at times if the dead fish, frogs, worms, and crayfish are not just being replaced by equally inanimate chemicals and glassware. Granted that the problems of keeping living organisms in the laboratory can sometimes be prohibitive, I think it would be possible to put into the hands of students living organisms to be studied over an extended period of time. It appears that what is happening is that at intervals during the school year living specimens are brought into the laboratory, used for one or two periods, and then disposed of promptly and, of course, hygienically. I propose here what I will call a "free experimental" system and hope that in some situations it would be an aid to integrating laboratory and lecture material, giving each student access to equipment that is at a minimum as well as giving the student an opportunity to experience the study of biology as an investigative process—a process of discovery.

The approach is basically the same as that outlined in the *Laboratory Blocks* by the BSCS, differing in that groups of students are working in the laboratory with different organisms. Instead of all of the students working with the same problem using the same organism for several weeks, groups of students are assigned the same experimental problem but called upon to resolve it using dissimilar organisms and, consequently, different experimental systems.

At the beginning of the school year the students are divided into groups of two or three and given a living organism for which they are responsible. At this time the teacher provides information as to the kind of care the organism will require and gives the students the necessary materials. I suggest the following organisms that might be maintained in the laboratory with a minimum of care but in sufficient numbers: paramecium, euglena, guppies, goldfish, frogs, fruitflies, ants, planaria, meal worms, bacteria, daph-

nia, hydra, mice, plants (marigolds and coleus are especially good laboratory plants), and even earthworms. The range of choice is wide, the main determining factor being the size of the laboratory and the experience the teacher has had with different organisms.

As biology is usually the first laboratory science taught in high school, it will be necessary to introduce the students to equipment and techniques before their attention is focused primarily on problems relating to the living organism. During the first few months of the school year the students follow procedures delineated in a good laboratory manual. The exercises are chosen so as to guide the students toward the following goals:

1. A facility in using laboratory equipment. If it is not possible to provide sufficient material for each student, it might be well to stagger the laboratory exercises so that different sections of the class are using different pieces of equipment.
2. An understanding of the way laboratory procedures are set up. Before the student actually carries out an exercise it might be helpful to require a written procedure from him in outline form. He should also be familiar with the graphic and statistical analysis of data.

When the students have acquired some skill in the laboratory and have available a number of living organisms, they are presented with a research problem. For example, the students might be asked to determine the effects of a ten degree change in temperature on the life span of the organism or the effects of a chemical such as acetlysalicylic acid in varying concentrations. Each group is asked to plan an experiment or even a group of experiments that will suggest answers to the problem. It may happen that a given problem is not soluble in terms of the organism, at least in the time available for laboratory work. In this case, another related problem is posed. It may, in some instances, be advantageous for groups to combine, putting aside for the time being laboratory work on one organism.

There are several difficulties built into such a laboratory system. If the students are allowed to pace their own work it may be necessary for them to have access to the laboratory outside of actual class time. In some situations this may be impossible. Also, the laboratory period may tend to become free and unstructured to the extent that the students are wasting class time. I would offer several suggestions that might allay this. First of all, a laboratory manual might be used as a structuring medium for all laboratory work; the students in this case follow consistently manual procedures but apply them to the different organisms with which they are working. This will make it necessary for the student to adapt the procedures to the organism and to be critical in interpreting the results. This plan could be supplemented for individual groups by suggesting problems that are not directly treated in the laboratory manual. Second, the laboratory periods might be organized so that only one out of two or three periods is devoted to free experimental work by the student. Third, the actual group work with a given organism may be treated as merely a class related activity. This would make it possible to keep different organisms alive in the laboratory with students caring for them and provide a number of dissimilar organisms for projects when they are called for by laboratory manual procedures.

As the students work with the different organisms they become aware of the variability of the living systems. Though it is possible to generalize biological principles it is, at the same time, impossible to lay down hard and fast rules that will apply unequivocally to even the limited number of organisms in the classroom. They also begin to understand science as primarily a way of thinking, a manner of approaching a problem systematically. Through contact with other students working on similar problems there develops an insight into the interdependence of observed phenomena. The fact that each student works for some time with one organism helps to give continuity to the laboratory work which seems to be lacking when the student merely follows a procedure, records data, cleans the laboratory equipment and closes the book until the next period.